

FINAL TECHNICAL REPORT

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Title: Northeast Regional Planetary Data Center

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I. BACKGROUND

In 1980, the *Northeast Planetary Data Center* (NEPDC) was established with Tim Mutch as its Director. The Center was originally located in the Sciences Library due to space limitations but moved to the Lincoln Field Building in 1983 where it could serve the Planetary Group and outside visitors more effectively. In 1984 Dr. Peter Schultz moved to Brown University and became its Director after serving in a similar capacity at the Lunar and Planetary Institute since 1976. Debbie Glavin has served as the Data Center Coordinator since 1982.

Initially the NEPDC was built around Tim Mutch's research collection of Lunar Orbiter and Mariner 9 images with only partial sets of Apollo and Viking materials. Its collection was broadened and deepened as the Director (PHS) searched for materials to fill in gaps. Two important acquisitions included the transfer of a Viking collection from a previous PI in Tucson and the donation of surplus lunar materials (Apollo) from the USGS/Menlo Park prior to its building being torn down. Later additions included the pipeline of distributed materials such as the Viking photomosaic series and certain Magellan products. Not all materials sent to Brown, however, found their way to the Data Center, e.g., Voyager prints and negatives.

In addition to the NEPDC, the planetary research collection is separately maintained in conjunction with past and ongoing mission activities. These materials (e.g., Viking, Magellan, Galileo, MGS mission products) are housed elsewhere and maintained independently from the NEPDC. They are unavailable to other researchers, educators, and general public. Consequently, the NEPDC represents the only generally accessible reference collection for use by researchers, students, faculty, educators, and general public in the Northeast corridor.

IA. Collection: The extensive holdings of maps (5000) and photographs (450,000 prints, positives, negatives) of the NEPDC forms the core of the reference collection. Other supporting collections include an Abodia Slide System holding the extensive slide collection (over 6000). This system allows visitors to preview the collection without handling and provides storage for duplicates. In addition, the Center maintains about 300 videos, over 2000 CD-ROM's (not counting duplicates), 2000 books/documents, and 11 serials/journals. Other supporting equipment includes a Zoom Transferscope, TV/VCR, laser disc player, micro-form readers, light tables, and slide/movie projectors, and a series of computers and scanners (described below).

The Data Center is arranged in four areas:

Reference Room: At the entrance are the serial collections and book references with rotating exhibit space. A large (5' x 8') print from the successful Pathfinder Mission draws attention to the Data Center as visitors approach the second floor. The NEPDC Coordinator's office is centrally located within the Center in order to greet and monitor visitors.

Image/Map Collection: Deeper into the Data Center, the vast collection of hard-copy maps and images can be accessed. This area includes a large, central a large layout surface surrounded by Plan Hold Cabinets in which large format prints (Lunar Orbiter,

Viking Mosaics, lunar maps, and Magellan F-Maps). In the mid-80's, the Data Center was reconfigured to better accommodate researchers and visitors by adding a bank of map flats topped by an extended work surface. The bank of map flats holds maps/mosaics and serves as temporary storage for researchers who do need to have ready access during ongoing projects rather than refiling back into the collection. Over the last five years, a row of different types of computers has been added, including three Sun Ultra-10 workstations, Mac Power Book, E-machines with CD readers, and color printer.

Image Transfer Area: Over the last two years, the NEPDC Coordinator's office was moved in order to accommodate additional digital scanning devices and supporting PC. This room has more restricted access (for security) but is open to visitors. This move also meant that a general visitor's office had to be eliminated.

Storage Areas: The fourth area includes three, limited access areas, that hold negative, prints and reference materials. One area also provides more quiet workspace off the central collection. Another provides storage for limited access materials that require assistance from the Coordinator. A third space is shared with the RI Space Grant Program in an adjacent dual-purpose classroom/workspace and contains locked cabinets for deeper storage needs.

IB. Policy: The holdings of the NEPDC are principally reference sets, not to be removed except with explicit arrangements with the Coordinator or Director (principally photographing, copying, classroom use, meetings). Our policy tries to ensure monitoring the use, condition and location of its materials. This function differs, somewhat, from a research collection, which by its nature, often consumes prime-mission materials. Our policy evolved from experience: photos/maps disappeared, were returned with annotations, or suffered irreparable damage. Prints/negatives made from early first or second generation negatives are basically irreplaceable. Hence, the Data Center materials are not considered "archived"; rather, they are considered "reference" products. Research materials from ongoing and past missions (Voyager, Magellan, MGS, Galileo) exist elsewhere within the Lincoln Field Building but are not part of the Data Center holding or control.

IC. Supporting Computers: Independent of Data Center support, the Planetary Geology Group at Brown has an active research program. Because of this program, there had been a perception that computers elsewhere in the building supported Data Center needs. Consequently, annual requests to add computers to the Data Center and move into the digital age were not approved until relatively recently. But the Planetary Geology Group's equipment, was for ongoing PI- related research and had neither support for, nor access by, Data Center visitors (including students and faculty not associated with the PI's research). Six years ago the Data Center was finally given a one-time augmentation to purchase critically needed equipment including a Sun Ultra-10 Workstation, Mac Power Book, and other supporting equipment (printers, scanners). This at last replaced the single MacIIsi, which had been the only computer available.

Over the last full proposal cycle, we re-allocated funds to purchase a color printer (HP color laser), large format scanner (HP Scanjet 5740c), 16 mm to 70 mm scanner, two additional Sun/Solaris Ultra-10 workstations (a two-for-one opportunity), and two e-machines (additional web access). The Appendix details our current resources.

Consequently, there is now considerable diversity in the types of systems available to users. Much of the building is Mac-based (excepting the large remote-sensing systems) and this flexibility is welcomed. Our computers now provide daily access by visiting researchers, classroom use, students, and educators. Image processing using various on-line products or CD-ROM's are placed in context by directly accessible maps and photos in the Data Center holdings.

Although our Data Center Coordinator is increasing her computer skills, her primary role is (and should be) the maintenance of the large reference collection of maps and images and visitor requests. In the past we have supported the Planetary Geology Group system analyst for our DC systems and networking needs. The system analyst primarily maintains/upgrades for the network, software upgrades, security and equipment maintenance. This arrangement, however, is becoming difficult with the increase in the amount of digital data, need for compute assistance, and desire to produce DC processing products for display or for specialized assistance. As described in our work plan, we will be making greater use of undergraduate students.

ID. Summary: The international system of Regional Planetary Image Facilities provides an important network of facilities enabling data recovery and analyses of the planetary geologic record. The NEPDC's specific strength is its extensive collection of hard-copy image products and supporting documents. This collection provides a reference center for research and education about the solid surface planets. It is also a regional focal point for public information and resources related specifically to Planetary Geology or NASA-related events. For example, the Data Center hosted a group of students who wanted to watch the Columbia memorial service over NASA-select. Local television stations featured this gathering and asked students about the future of the space program, including future Mars exploration. Lastly, the NEPCD provides a home for abandoned, yet historically and functionally important planetary image products. We maintain a clear distinction between Data Center support and services from PI-supported research.

IE. University Commitment: Brown University continued to provide space, personnel (Data Center Coordinator salary and benefits), and a significant university contribution. This commitment by the Brown Administration underscores its recognition that the Data Center plays an important role for a sustained planetary research program, for undergraduate educational experience, and for a regional presence of planetary exploration. Eight years ago, the University made a further significant investment when they replaced the aging environmental control system in the Data Center at a cost of \$40,000. We estimate that the University provides well over a 1:1 match to NASA's support each year. As an illustration, a recently published large coffee-table book called "Brown: Images of the University" included the Data Center. The Data Center has become part of the fabric of the university.

II. RESEARCH SUPPORT

The Northeast Planetary Data Center provides three primary research functions for the region: research, education, and outreach. Students (graduate and undergraduate), and researchers (visiting and resident, and faculty) represent our primary "customers". Our facility does this in three ways: reference materials, networking support (materials not part of our holdings), and first-level searches. Its primary function is the maintenance of relevant research reference materials. Neither the Data Center Coordinator nor the Director acts as an advisor or assistant for ongoing research. Rather, their role is to assist in inquiries about availability, data quality, and support documentation.

The NEDP customer base extends beyond the RI borders and over the last three years included international visitors (Russia, Finland, Japan, Germany, Great Britain, Australia, Argentina, Mexico). Visiting researchers using the facility have included Misha Ivanov, Misha Kreslavsky, Alexander T. Basilevsky, Uli Kohler, Marcelo Zarate, Patrick Pinet, Paul Stoddard (No. Illinois U.), and Lionel Wilson. Within the northeast region, we provide support for faculty and their students from the Community College of Rhode Island, Rhode Island College, Bryant College, Wheaton College, and the University of Rhode Island.

Additionally, the Data Center often has visitors who stop by during their trips to the campus. Over the last three years the following visitors of note are recorded: Bernard Fong (Chief Scientist, ESA), Wesley Huntress, Rie Hardu (ISAS), David Marchant (Boston University), Bruce Simonson (Oberlin), Charles Frankel (science writer), James Garvin, Bevan French (Smithsonian), and numerous others.

The Data Center has provided support for several mission-related (both ongoing and proposed) research efforts including Clementine, Lunar Prospector, Magellan, Mars Global Surveyor, Aladdin, Deep Impact, Janus, South-Pole Aitken, Messenger and Dawn. Research projects have made use of Lunar Orbiter, Viking (Orbiter and Lander), Apollo, Pathfinder, Mariner 10, Mariner 9, Magellan, and Clementine data products from the Data Center's holdings. It also has borrowed selected Voyager, Magellan, and Galileo products from the research collections, when appropriate and available.

During the report period, the Data Center supported a summer high school student and an undergraduate to compile and print a set of LAC maps based on Clementine images. This collection now extends across the farside, polar regions, and remaining nearside left incomplete since the 70's. The collection is available on a CD-ROM and as hard-copy (20"x24") maps. The data set has been used for various research projects.

Research projects supported over the last three years have included mapping of tectonic terrains/provinces on Venus, mapping Venus channels, erosion of Martian surface features, impact crater run-out flows on Venus, oblique impact crater morphologies, Martian impact crater ejecta, lunar volcanism, lunar mare/highland boundary transitions, Viking block size distributions, cryptovolcanic studies, Pathfinder analyses, lunar swirls, Martian polar studies, Phobos/Deimos studies, targeted crater studies (South Pole Aitken Basin, Tycho, Tsiolkovsky, Crisium, Imbrium, Orientale), and numerous other projects. More than a dozen theses have been or are supported by the Data Center (S. Sugita, R. Milliken, Lin Li, Emily Stewart, Noah Petro, Elizabeth Fuller, J. Anderson, J. Dahl, M. Staid, K. Fishbaugh). Undergraduates regularly use the Center for undergraduate thesis research during the year and over the summer.

III. EDUCATION FUNCTION

IIIA. Higher Education: At Brown, the Data Center supports five different (geology and physics) undergraduate classes and six graduate classes. Three classes make extensive use of the collection of images and maps each year as an integral part of hands-on projects. Additionally, undergraduate and graduate classroom field trips (e.g., Meteor Crater, Hawaii, Owens Valley) used materials from the Data Center. Previous seminars in Biology, Engineering, and Archaeology also have made use of reference materials in the Data Center.

But the Data Center also draws users from beyond the Brown campus. The Rhode Island School of Design offers a Studio Design Course (both undergraduate and graduate levels) that involves designing for extreme environments (e.g., living on Mars and in the Space Station). This course and its products has received national recognition. In 2002 the Data Center hosted this class, and students returned to use its resources throughout the semester. Materials from the Data Center also provided support for field trips to the Colorado Plateau by faculty and students from the University of Rhode Island. This trip provided terrestrial analogs for features on Mars.

For the last 20 years, the principal Teaching College in Rhode Island (Rhode Island College) has brought three separate classes annually as part of their Science Methods for Educators course. Such class visits help to make future educators aware of planetary studies as a tool for teaching physics, math, chemistry, and earth science. As a result, teachers later return to the Data Center in order to get the latest information for their classroom. Other institutions of higher learning making occasional use include the Community College of Rhode Island, University of Rhode Island, Bryant College, Providence College, Wheaton College, and Bridgeport College (Mass.). Conservatively, the NEPDC serves about 200 undergraduates and 15-20 graduate students annually.

There is a growing trend for both Masters and Ph.D. students choosing to teach at colleges and universities rather than primarily pursuing research. Colleges in Connecticut, Massachusetts, and Rhode Island currently have recent graduates (both Masters and Ph.D) with planetary backgrounds on the faculty including Wesleyan, Wheaton, Bryant, University of Rhode Island, and the Community College of Rhode Island. In addition, the Rhode Island Space Grant (RISG) involves ten other affiliate institutions of higher learning within its consortium. Consequently, the customer base for the Data Center continues to grow.

IIIB. Pre-College: The NEPDC partnered with several institutions active in pre-college education: the Rhode Island Space Grant Program; Roger Williams Natural History Museum and Cormack Planetarium, the Teach Educator Resource Center (TERC at Rhode Island College), Ladd Observatory (at Brown), and the Challenger Center (nearby Massachusetts).

Although our Data Center does not create classroom activities, it does provide images (photographs, slides) CD-ROM's, maps and information. Also, the Data Center provides a meaningful field trip for educators, administrators, students, and their parents. This direct connection between a research-service facility and educator community is

quite unique. We don't see ourselves as competitors but as a complementary resource, if not advocate, for NASA's diverse educational programs, both locally and regionally.

Pre-college students also have made use of the Data Center. Two high school students used the Center for science projects (both female, one an under-represented minority). One of the students used the new computing facilities to develop Mercator projection sets (following the LAC formats) from the newly released Clementine mosaics.

A major Data Center user group includes the RI Space Grant (RISG) Fellows and Scholars. This RISG program asks that 25% of the student time be used for K-12 teacher partnerships and classroom presentations across RI. This strategy not only supports students in their research but also rekindles their enthusiasm by talking about what they do. Solar System themes and planetary geology is a frequent topic and students use maps, videos, slides, and CD's in their presentations.

IIC. Summary: The PDC is actively involved in the regional educational community but recognizes that it is not a Planetarium, museum, or distribution center. We are a resource directly tied to active research in planetary studies. This resource is used at all educational levels. At the university/college level we provide reference materials for courses, and special projects. At the pre-college level, we provide access to scientists involved in solar system exploration. Our intent is to connect with educators as professionals who want to learn more or who want to introduce their students to a direct connection with NASA programs. Each year we are visited by over 20 classrooms, almost 250 teachers, and 970 students. And we partner with other programs to advocate greater understanding of science through studies of planetary surfaces and environments. We distribute their brochures in the Data Center and they distribute ours.

IV. OUTREACH FUNCTION

IVA. Open Houses. An important role for the Data Center is its connection with the public. We do this through a variety of mini-Open Houses throughout the year. Each October the Planetary Data Center holds an Open House in conjunction with Parent's Weekend at Brown. This Open House is advertised campus-wide through the George Street Journal, a Brown weekly publication, through the Brown News Bureau, and through fliers distributed at various locations on campus. This event offers students who have taken Planetary Geology courses an opportunity to show their parents how they have utilized the Data Center for their research, course work and for just browsing the images and other data. We also see many students and parents who wander in intrigued by our signs posted by the entrance to the building. Many parents express how pleased they are that our facility is just as accessible to undergrads as it is to graduate students and researchers. During this Open House, which usually runs from 9 a.m. to 2 p.m. both Saturday and Sunday, we have displays of the most current planetary images, continuous space videos, and tours of the Data Center. Refreshments are served and the number of visitors is usually 160 to 260.

Commencement Weekend at Brown is always Memorial Weekend and the Planetary Data Center holds an Open House in conjunction with this event each year. This open House is advertised campus-wide through the George Street Journal, a Brown

weekly publication, through the Brown News Bureau, and through numerous Commencement publications distributed to alumni, students and parents. This is a very exciting event for the Data Center. Our visitors include many alumni, including former Geology students and Planetary Geology graduates. Students, who have taken only one or two planetary geology courses, take advantage of the Open House to revisit the Data Center to see the latest information. Many former students return to touch base with Dr. Schultz and other faculty. Many of the visitors are educators who literally fill bags with planetary hand-out sheets, and establish mail and email links with the Data Center for future contact.

Each year the Saturday of Commencement Weekend features a number of "forums" with guest speakers. Several of these forums in recent years have featured "planetary" themes and the featured speakers have encouraged their audience members to stop by the Data Center to see the collections. For this Open House we have displays of the latest planetary images, continuous space videos, and tours of the Data Center. Refreshments are served and we usually have between 200-250 visitors.

IVB. Other Outreach. The Annual New England/NASA Business and Technology Conference takes place in August and Providence has been its host for the last three years. Although the primary objective of the conference is to link businesses and business leaders with NASA to forge working relationships, it also provides an opportunity to expose this community (including business leaders) to the Planetary Data Center. We co-host a display area (with the RI Space Grant and the Educator Resource Center) and reach over 400 attendees annually. We use a large 8x8-foot exhibit unit to display a wide variety of NASA images and provide a large number of handout materials. Many of the conference attendees take materials for their children's teachers, spouses who teach and just to have some images to put up in their offices.

We also watch for other opportunities to broaden awareness. For example, last year (September, 2002), the NE Planetary Data Center worked with (and supplied materials for) the IMAX Theater for its premier of "Apollo 13". A large print from the Apollo 11 landing greeted visitors, and NASA videotapes from other Apollo missions played continuously in the lobby and a short description of the Data Center continuously played between each IMAX showing. On the eve of the VIP premier, the Data Center distributed "Space Cubes" (with its name attached) and handed out small plastic astronauts.

The Data Center also met with the new Heritage Harbor Museum being built in Providence. They are working with the Smithsonian to bring a rotating exhibit about lunar exploration, and the NE Planetary Data Center will be providing supplemental materials, as well as advice. The Museum won't open until 2005 but will provide an important new public partner.

Over the last three years, the NEPDC has arranged for speakers at various amateur Astronomy conventions including Astro-Assembly in Rhode Island (banquet speaker), Astronomy Jamboree in Long Island, New York (two different years), and StarConn in Hartford, Connecticut. Amateur astronomy clubs continue to be active supporters for NASA's planetary exploration program.

Other public events have included various Girl Scout, Boy Scout, and senior citizen groups. The RI Society of Mechanical Engineers visited the Data Center in the

fall of 2001 and the Director gave an evening talk. One of the attendees looked unusually attentive. It was Jack McCauley's son. This chance meeting permitted reconnecting with this past Chief of the USGS-Astro-geology Branch, now retired in Florida.

The Data Center continues to be used as a backdrop for current events related to space exploration. For example, several television stations visited the NEPDC during the Leonid Meteor shower and during/following the Columbia disaster. A group of students designed an impact experiment that flew on the KC-135 "vomit comet." Their story was featured on a local television station and they used the Data Center as "the place to be."